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IS 4559 (1993): Single operator rectifier type dc arc welding power source [ETD 21: Electric Welding Equipment]

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एक चालक दिष्टकारी टाइप डी सी आर्क वेल्डन पावर  
स्रोत - विशिष्ट  
( दूसरा पुनरीक्षण )

*Indian Standard*

SINGLE OPERATOR RECTIFIER TYPE  
dc ARC WELDING POWER SOURCE —  
SPECIFICATION

( *Second Revision* )

UDC 621.791.75.03

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BUREAU OF INDIAN STANDARDS  
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## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electric Welding Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1968 and this revision has been undertaken to make it up to date, and include thyristorized arc welding rectifier power source.

This standard deals with rectifier welding power sources incorporating solid state rectifiers.

Rectifier type arc welding power source shall be either with ac/dc output or with dc output only. This standard is intended to cover the later type only while IS 6008 : 1971 'Specification for single operator ac/dc arc welding power source' deals with the former type.

In preparing this standard, assistance has been derived from the following:

ISO 700-1982 Power sources for manual metal arc welding with covered electrodes and for the TIG process. International Organization for Standardization.

BS 638 : Part 2 : 1979 Arc welding power sources, equipment and accessories: Part 2 Specification for air cooled power sources for manual metal-arc welding with covered electrodes and for TIG welding. British Standards Institution.

Pub No. EW 1 : 1983 Electric arc welding power sources. National Electric Manufacturers' Association, USA.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# SINGLE OPERATOR RECTIFIER TYPE dc ARC WELDING POWER SOURCE — SPECIFICATION

( Second Revision )

## 1 SCOPE

**1.1** This standard lays down the requirements and tests for single operator arc welding power sources incorporating solid state rectifiers and also thyristers and having drooping characteristics.

**1.2** This standard does not cover 'constants potential' and other special type of arc welding power sources.

## 2 REFERENCES

**2.1** The Indian Standards listed in Annex A are necessary adjuncts to this standard.

## 3 TERMINOLOGY

**3.0** For the purpose of this standard, the following definitions shall apply.

### 3.1 Load Characteristics

The specified relationship between load voltage and load current of arc welding power source.

### 3.2 Manual Metal-Arc Welding ( Hand Welding )

Metal-arc welding with consumable electrodes not exceeding 460 mm in length and applied by the operator without automatic or semiautomatic means of replacement.

### 3.3 Semiautomatic Arc Welding

Metal-arc welding in which the arc length is automatically controlled but the positioning of the arc is manual.

### 3.4 Automatic Arc Welding

Metal-arc welding in which the arc length and the travel of the electrodes or the work pieces are automatically controlled.

### 3.5 Duty Cycle

The ratio of time during which the output side of the arc welding power source is loaded, to the total elapsed time, the primary side being energized throughout.

### 3.6 Maximum Continuous Hand Welding Current

The maximum welding currents which the welding power source is capable of delivering when

engaged continuously for manual metal arc welding, at the specified load voltage and duty cycle without exceeding the specified temperature-rise.

### 3.7 Maximum Hand Welding Current

The maximum welding current for which the arc welding power source is calibrated for manual metal arc welding at the specified load voltage.

### 3.8 Minimum Hand Welding Current

The minimum welding current for which the arc welding power source is calibrated for manual metal arc welding at the specified load voltage.

### 3.9 Minimum Automatic Welding Current

The minimum welding current for which the arc welding power source is calibrated for automatic or semiautomatic metal-arc welding at the specified load voltage.

### 3.10 Maximum Continuous Automatic Welding Current

The maximum welding current which the arc welding power source is capable of delivering for continuous operation on automatic or semiautomatic arc welding at the specified load voltage and duty cycle without exceeding the specified temperature-rise.

### 3.11 Open Circuit Voltage

The voltage between the output terminals of the arc welding power source when no current is flowing in the welding circuit.

NOTE — This does not include superimposed high frequency voltage and voltage derived from low voltage safety device.

### 3.12 Load Voltage

The voltage between the output terminals of the arc welding power source when a specified current is flowing.

### 3.13 Rating

A statement of operating parameters assigned to the arc welding power source by the manufacturer under specified conditions.

### 3.14 Type Tests

Tests made on an arc welding power source which is representative of other arc welding power sources to demonstrate that they comply with specified requirements.

NOTE — An arc welding power source is considered to be representative of others if it is identical in rating and construction.

### 3.15 Routine Tests

Tests carried out on each arc welding power source to check requirements which are likely to vary during production.

## 4 RATING

### 4.1 Rated Input Voltage

The preferred rated input voltage shall be 415 V.

NOTE — In case of a rectifier type arc welding power source suitable for 415 volts, supply should be taken either from two lines or three lines of three phase supply depending upon whether the power source is designed for connection to two or three lines of a three phase system.

### 4.2 Rated Frequency

The rated frequency shall be 50 Hz.

### 4.3 Rated Open-Circuit Voltage

The open-circuit voltage of the arc welding power source shall not exceed 100 V.

NOTE — Where it is required to control the open-circuit voltage for safety purposes, suitable safety devices may be incorporated to bring down voltage to the desired value.

### 4.4 Rated Current

The rectifier type arc welding power source shall be rated at current and duty cycles corresponding to maximum continuous hand welding current. Preferred current ratings shall be:

150, 200, 300, 400, 500, 600, 900 and 1200 A.

#### 4.4.1 Minimum Hand Welding Current

The minimum hand welding current shall not be more than 20 percent of the rated current at the specified load voltage.

#### 4.4.2 Minimum Automatic Welding Current

It shall be a matter of agreement between the purchaser and the supplier.

#### 4.4.3 Maximum Hand Welding Current

The maximum hand welding current shall not exceed 1.35 times the rated current at the specified load voltage.

### 4.5 Duty Cycle

The rated duty cycle at maximum continuous hand welding current shall be taken as 60 percent;

the total duration of each cycle shall be 5 minutes comprising of a period, 3 minutes of load followed by a period, 2 minutes of no-load operation.

4.5.1 The rated duty cycle at maximum continuous automatic welding current shall be taken as 100 percent. Duty cycles other than 100 percent shall be a matter of agreement between the purchaser and the supplier.

4.5.2 The rated duty cycle at maximum continuous semiautomatic welding shall be a matter of agreement between the purchaser and the supplier.

### 4.6 Tolerance on Open-Circuit Voltage

The permissible tolerance for the open-circuit voltage(s) shall be  $\pm 5$  percent subject to limitation given in 4.3.

## 5 NORMAL SERVICE CONDITIONS

5.1 This standard applies to rectifier type arc welding power sources operating under the following normal service conditions (see also 11.7.3):

- |                                  |         |
|----------------------------------|---------|
| a) Reference ambient temperature | 40°C    |
| b) Altitude not exceeding        | 1 000 m |

## 6 DESIGN AND CONSTRUCTION

6.1 The rectifier assembly shall be isolated from the mains supply by a double wound transformer. Output terminals shall be insulated from the enclosure and shall be suitably protected against accidental or inadvertent contact.

6.2 Monocrystalline rectifiers shall be of adequate current carrying capacity and able to withstand, with surge devices, if fitted, transient voltages likely to occur from arc welding and allied processes. These rectifiers shall comply with IS 3895 : 1966.

6.3 Polycrystalline rectifiers (metal rectifiers) shall comply with IS 2511 : 1963, except for the voltage test which shall be in accordance with 11.8 of this standard.

6.4 The arc welding power source shall be capable of:

- a) withstanding the full specified supply voltage without the necessity for reforming the rectifier cells by the application of reduced voltage; and
- b) withstanding an ac voltage instantaneously applied and maintained for 5 minutes which is 10 percent higher than the voltage appropriate to the selected preliminary voltage tapping. It shall also be able to withstand repeated switching off of the ac supply at the same excess voltage when the dc output terminals are not connected to an external load.

## 6.5 Frame and Enclosure

The arc welding power source shall be so manufactured that it has the strength and rigidity necessary to withstand rough usage. It shall be provided with an enclosure or tank which shall enclose all live metal parts other than a flexible supply cord or cable and output terminals.

**6.5.1** The enclosure or tank shall be so constructed as to exclude vertically falling water or dirt in case of a drawbar being provided, the same should be suitably locked.

**6.5.2** The enclosure of the tank shall be provided with suitable lifting lugs. In case of oil-immersed power sources, an oil level indicator and a drain plug shall also be provided.

**6.5.3** In case of a portable arc welding machine the wheels used shall be either of cast iron, solid rubber type or a UHMWPE ( ultra high molecular weight polyethylene ).

## 6.6 Earthing

Two earthing terminals shall be provided for two separate and distinct connections to earth of all metallic parts which are not intended to carry current. Earthing terminals shall be suitably protected against corrosion and shall be metallically clean. Earthing terminals shall be marked indelibly with the symbol  $\perp$

## 6.7 Protection Against Corrosion

All metallic parts and surfaces of the assembly shall be suitably protected against corrosion.

## 7 CAPACITORS

**7.1** Capacitors may be used to improve the power factor to approximately 0.85 lagging at 50 percent of the maximum continuous hand welding current at the specified load voltage ( see Table 1 ).

**Table 1 Welding Current and Welding Load Voltage  
( Clauses 7.1, 9.2 and 11.5 )**

Welding Current <i>A</i>	Welding Load Voltage <i>V</i>
( 1 )	( 2 )
150	26
200	28
300	32
400	36
500	40
600 and above	44

NOTE — The above load voltages are based on the formula  $U = 20 + 0.04 I$ , where  $U$  is the load voltage and  $I$  is the load current. This formula is applicable to all welding currents up to 600 A.

**7.2** The capacitor, if provided as part of the arc welding power source, shall conform to IS 2834 : 1986.

**7.3** The capacitor shall be so connected that it is switched off with the arc welding power source.

## 8 CONTROL AND PROTECTIVE DEVICES

**8.1** If a switch, controller or circuit breaker is employed in the rectifier type arc welding power source, it shall be suitable for the particular application and shall conform to the relevant Indian Standard(s).

**8.2** Contacts of all regulating taps, if provided, shall be such as to make positive contact between moving and stationary contacts. Visual indicator shall be provided to indicate the current setting.

## 8.3 Remote Control Devices

Remote control devices, if provided, shall not operate at voltages exceeding 110 V. For supply to the control circuits, power shall be taken from a winding electrically isolated from the supply mains.

## 9 PERFORMANCE

**9.1** The arc welding power source shall be capable of operating continuously delivering maximum continuous hand welding current at the specified duty cycle without overheating.

## 9.2 Indication and Accuracy

The arc welding power source shall carry a means of indicating the load current which takes into account the relationship between conventional load voltage and conventional welding current as given in Table 1. The accuracy of this indication shall be within  $\pm 10$  percent of true value unless the maximum output current exceeds ten times the minimum output current. In this case, the accuracy at minimum current shall be:

$$\pm \frac{I_{\max}}{I_{\min}} \text{ percent}$$

and the accuracy at maximum current shall be  $\pm 10$  percent, with the accuracy varying linearly between these two values.

Whatever the method of regulation, the difference between the indicated currents corresponding to two successive positions of the setting device shall in no case exceed 15 percent of the higher of the two indicated currents.

## NOTES

**1** Subject to agreement between the purchaser and the manufacturer, scales graduated to indicate the current under other than conventional load voltages may be fitted for specific purpose.

**2** In exceptional cases where because of the design of the welding equipment ( for example, devices with dual control ), it is impracticable to obtain a graduated scale for currents for conventional load voltage, it is recommended that the manufacturer provide on the equipment, an ammeter of class index 2.5 [ see IS 1248 ( Part 2 ) : 1983 ], properly damped, to indicate the welding current.

## 10 MARKING

**10.1** The following information shall be given on the rating plate:

- a) Indication of the source of manufacture;
- b) Reference to this Indian Standard, that is, Ref to IS 4559 : 1993;
- c) Type and manufacturer's serial number;
- d) Range of welding current, minimum and maximum;
- e) Maximum continuous hand welding current;
- f) Maximum continuous automatic welding current;
- g) Duty cycle at maximum current;
- h) Input current at rated output at 60 percent duty;
- j) Rated input voltage, frequency and number of phases;
- k) Open circuit voltage, minimum and maximum;
- m) Type of cooling;
- n) Mass;
- p) Class of insulation;
- q) Country of manufacture; and
- r) A warning worded as follows:

**WARNING :** Currents in excess of the following are for intermittent use only:

For hand welding ..... Amperes  
 For automatic welding ..... Amperes

**10.2** Arc welding power sources shall be fitted with a current calibration chart.

**10.3** The polarity of the output terminals shall be marked in relation to the polarity in the following manner:

- a) Positive terminals as '+', and
- b) Negative terminals as '-'.

In case a polarity changeover switch is provided, the polarities marked are for straight connections only.

**10.4** The arc welding power source may also be marked with the Standard Mark.

## 11 TESTS

**11.1** Tests shall be made to prove compliance with all the requirements of this standard.

### 11.1.1 Type Tests

These tests may be made by mutual agreement between the purchaser and the supplier and if the records of type tests on arc welding power

source which, in essential detail, is representative of the one being purchased (see 3.14) are furnished; the purchaser may accept these as evidence of 'type test' instead of actual tests. Type tests and their sequence shall be as follows:

- a) Insulation resistance test ( 11.2 ),
- b) Over voltage test ( 11.3 ),
- c) Open-circuit voltage test ( 11.4 ),
- d) Load characteristic test ( 11.5 ),
- e) Short-circuit test ( 11.6 ),
- f) Temperature-rise test ( 11.7 ),
- g) High voltage test ( 11.8 ), and
- h) Insulation resistance test ( repeated ) ( 11.2 ).

### 11.1.2 Routine Tests

The routine tests and their sequence shall be as follows:

- a) Insulation resistance test ( 11.2 ),
- b) Open-circuit voltage test ( 11.4 ),
- c) Load characteristic test ( 11.5 ),
- d) Short-circuit test ( 11.6 )
- e) High voltage test ( 11.8 ), and
- f) Insulation resistance test ( repeated ) ( 11.2 ).

**11.1.2.1** A certificate of routine tests shall be furnished by the manufacturer which shall show that each of the arc welding power source has been subjected to the tests specified in 11.1.2 and that it complies with the requirements specified in this standard for these tests and that each of the arc welding power source has been found to be sound electrically and mechanically and is in working order in all particulars.

### 11.2 Insulation Resistance Test

For the purpose of this test, the rectifier cells shall be short-circuited on both the ac and dc sides while remaining connected to the transformer. Protective or filter devices or capacitors shall be disconnected or short-circuited as desired.

**11.2.1** The insulation resistance before and after high voltage test shall be not less than 2 meg-ohms. The insulation resistance shall be measured with dc voltage of about 500 V applied for a sufficient time for the reading of the indicator to become practically steady, such voltage being taken from an independent source or generated in the measuring instruments.

### 11.3 Over Voltage Test

An over voltage test shall be made as specified in 6.4 followed by repeated switching off of the ac supply, 50 times, at the same excess voltage when the dc output terminals are not connected to an external load.

#### 11.4 Open-Circuit Voltage Test

With the input side connected to the rated input voltage and output side open-circuited, the open-circuit voltage shall be measured.

#### 11.5 Load Characteristic Test

For the purpose of this test, the input side of the arc welding power source shall be connected to rated input voltage and the output terminals shall be connected to a variable resistive load. The associated load currents and load voltages shall be as given in Table 1.

#### 11.6 Short-Circuit Test

Steady short-circuit current at maximum setting within the range specified shall not be more than 200 percent of the welding current corresponding to this setting. Under short-circuit conditions, the voltage between output terminals shall not exceed 3 volts.

**NOTE** — Care shall be taken to ensure that this test does not take more than 10 seconds.

#### 11.7 Temperature-Rise Test

##### 11.7.1 Test Conditions

**11.7.1.1** The load should be a non-inductive resistance at appropriate load voltage. A tolerance of  $\pm 10$  percent shall be allowed on the value of this load voltage.

**11.7.1.2** Test shall be made at the rated input voltage.

**11.7.1.3** Arc welding power sources suitable for hand welding shall be tested for temperature-rise at a current equal to the maximum continuous hand welding current and at the duty cycle equal to 60 percent.

**11.7.1.4** Arc welding power sources suitable for both semiautomatic and automatic welding shall be tested for temperature-rise at a current equal to the maximum continuous automatic welding current and at a duty cycle equal to 100 percent.

**11.7.1.5** The temperature-rise test shall continue until steady maximum temperature is obtained. If the temperature-rise does not vary by more than  $2^{\circ}\text{C}/\text{h}$ , it is considered that steady temperature has been achieved.

**11.7.2** When measured in accordance with IS 9678 : 1980, the temperature-rise shall not exceed the limits specified in Table 2.

**Table 2 Limits of Permissible Temperature-Rise  
( Clause 11.7.2 )**

Sl No.	Parts	Class A Insulation		Class E Insulation		Class B Insulation		Class F Insulation		Class H Insulation	
		T °C	R °C	T °C	R °C	T °C	R °C	T °C	R °C	T °C	R °C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	Windings	55	60	65	75	70	80	85	100	105	125
ii)	Oil	50	—	—	—	—	—	—	—	—	—
iii)	Uninsulated parts including cores not in contact with insulated windings	The temperature-rise shall in no case reach such a value that there is risk of injury to any insulation material on adjacent parts or to the welding plant in any respect									

#### NOTES

1 T = by thermometer.

R = by resistance.

2 The numerical values quoted for classes F and H should be considered as tentative only and may be revised and use when more practical experience is available. If Class C insulation is used, the temperature-rise shall be a matter of agreement between the purchaser and the supplier.

3 For details of classes of insulation, see IS 1271 : 1985.

**11.7.3** For ambient temperature exceeding 40°C or altitude more than 1 000 m or both, the derating factor shall be subject to agreement between the purchaser and the supplier.

### 11.8 High Voltage Test

For the purpose of this test, rectifier cells shall be short-circuited on either or both the ac and dc sides while remaining connected to the transformer. Protective or filter devices or capacitors shall be disconnected or short-circuited as desired.

**11.8.1** As type test, this test shall be applied at the conclusion of the temperature-rise test.

**11.8.2** The test shall be made with a single-phase alternating voltage as nearly as possible of sine-wave form and of any convenient frequency between 40 and 60 Hz.

**11.8.3** The rms or peak value of the applied voltages shall be measured. The rms value shall be as follows:

- a) For the transformer alone when tested prior to inclusion in the complete unit, 2 000 volts;

- b) For the complete unit except as for (c) below, 1 500 volts; and
- c) For all auxiliary circuits not exceeding 110 volts to earth, 1 000 volts.

**11.8.4** The appropriate voltage, obtained from a separate source, shall be applied for 60 seconds to each winding in turn, between the winding under test and the remaining windings, core, frame and tank or casing of the transformer, connected together and to earth.

**11.8.5** The test shall be commenced at a voltage not greater than one-third of the test value, and shall be increased to the specified value as rapidly as is consistent with its magnitude being indicated by the measuring instrument. At the end of the test, the voltage shall be reduced rapidly to less than one-third of its full value before switching off.

NOTE — This test should not be carried out when the insulation resistance value is below 2 megohms.

**11.8.6** If this test is required to be repeated, the test voltage levels shall be reduced to 75 percent of the original values.

## ANNEX A ( Clause 2.1 )

### LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
1248 ( Part 2 ) : 1983	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 2 Ammeters and voltmeters ( second revision )	2511 : 1963	Polycrystalline semiconductor rectifier stacks
1271 : 1985	Thermal evaluation and classification of electrical insulation ( first revision )	2834 : 1986	Shunt capacitors for power systems ( second revision )
		3895 : 1966	Monocrystalline semiconductor rectifier cells and stacks
		9678 : 1980	Methods of measuring temperature-rise of electrical equipment

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